

NOV 10 1939

TULANE UNIVERSITY
SCHOOL OF MEDICINE

Modern Concepts of Cardiovascular Disease

Published monthly by the AMERICAN HEART ASSOCIATION

50 WEST 50TH STREET, NEW YORK, N. Y.

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Vol. VIII

November, 1939

No. 11

FLUCTUATIONS OF BLOOD PRESSURE

Blood pressure, like other manifestations of physiologic activity of the human body, is not static but labile. The experience of most physicians must have taught them this, yet they commonly maintain a contrary belief. This situation is abetted by a desire to reduce blood pressure by some therapeutic method for it is more gratifying to attribute decrease in blood pressure to treatment than to natural causes. Much confusion in regard to the efficacy of various therapeutic measures would be avoided if physicians would report not one blood pressure reading but three; that is, the maximal and minimal values determined by repeated calculations of blood pressure at several hourly intervals and the rough average blood pressure. Fluctuations in blood pressure also contribute to the difficulty in determining "normal" blood pressure since in determining the "normal" figure one does not know whether to use, for example, the "normal" figure of 120 mm. of mercury, which is the systolic blood pressure reading one day, or the figure, apparently equally normal, of 140 mm. which may be obtained the next day.

Fluctuation of Blood Pressure at Low Levels

We have emphasized that the systemic blood pressure is variable and that it reacts to various forms of external and internal stimulation. Mueller and Brown found variations of from 15 to 65 mm. of mercury in the normal systolic blood pressure and a mean variation of 36.5 mm. Brown and one of us (Hines) have devised a standard test for measuring the variability of the blood pressure. Immersion of a hand in ice water is used as the stimulus. They have shown that in the case of subjects with normal blood pressure the response to the cold stimulation is rather constant and there is a temporary increase in systolic and diastolic blood pressure. That this increase is closely correlated with the change in the blood pressure caused by environmental stimuli is shown by a comparison of the range of response of the blood pressure to the cold test with the range of variation of the blood pressure when it is taken at hourly intervals. The majority of subjects with normal blood pressure have a relatively small variability of the blood pressure with a range of approximately 10 to 20 mm. of mercury in systolic and diastolic blood pressure. Approximately 15 per cent of persons with a normal

blood pressure have a marked variability of the blood pressure and excessive reactions of the blood pressure to stimulation. The variability in the blood pressure in this group of "normal hyperreactors" will be approximately two to three times greater than the mean change among the group of "normal reactors."

The systolic and diastolic blood pressures may vary dissimilarly. In some instances there is considerable change in the systolic pressure and little change in the diastolic pressure. However, when there is a marked change in the diastolic pressure, there is usually a similar change in the systolic pressure. It is probable that there is considerable difference in the significance of a rise in the systolic blood pressure alone as compared with a rise only in the diastolic blood pressure. The diastolic response is the more reliable index of vasoconstriction. Changes in the systolic blood pressure alone are indicative of increased cardiac output, such as occurs in hyperthyroidism, effort syndrome and as the result of the effect of adrenalin.

Evidence which is accumulating indicates that unusual fluctuations of the blood pressure in subjects with normal blood pressure is indicative of a prehypertensive state. Unusual variations of the diastolic blood pressure and unusual response of the diastolic blood pressure to stimulation seem to be of special significance. Robinson and Bruce, following a detailed statistical and clinical study of a large group of persons, have concluded that the normal range of systolic blood pressure is between 90 and 120 mm. and that the normal range of the diastolic pressure is between 60 and 80 mm. Diehl and Hesdorffer have observed 155 students for a period of seven years and have found that young men showing even transitory elevation of the blood pressure during their college years are much more liable to have an elevated blood pressure after a period of from five to ten years than are students whose blood pressure was consistently within the normal range. The probabilities of their having hypertension in later years was found to be in direct proportion to the frequency of previous elevation of the blood pressure. One of us (Hines), in a follow-up study of 1,500 patients with originally normal blood pressures found that the majority (70.4 per cent) of the patients who, as a result of nervous stress,

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had an original elevation in systolic and diastolic blood pressure into the upper ranges of normal (140 to 150 mm. systolic and 85 to 100 mm. diastolic) had hypertension subsequently, whereas, only a small number (3.4 per cent) with original blood pressures in the lower ranges of normal had hypertension subsequently. None of the patients who had an original systolic blood pressure above 140 mm. but who had a diastolic blood pressure below 85 mm. had hypertension subsequently. A recent follow-up study of the original group of normal subjects studied with the cold pressor test by Brown and one of us (Hines) disclosed that 38 per cent of the "normal hyperreactors" had hypertension and that none of the "hyporeactors" had hypertension six years after the original study.

Fluctuations in Blood Pressure at High Levels

The blood pressure of patients who have hypertension varies widely. Mueller and Brown found that these variations are similar to those of patients with normal blood pressure but that the magnitude was about twice as great. We have studied the blood pressure of many patients while they were in the clinic and subsequently have made hourly readings for twenty-four consecutive hours while they were at rest in the hospital. In one group of cases in which the systolic blood pressure readings were more than 200 mm. of mercury when taken in the clinic, subsequent readings disclosed that the systolic blood pressure decreased about 50 mm. and the average diastolic blood pressure decreased about 35 mm. while the patient was at rest in the hospital. It is clinically true that the more severe the hypertension the less closely the blood pressure approaches normal as a result of rest and sleep. Clinical experience indicates that the probability of influencing the blood pressure satisfactorily by any therapeutic procedure is roughly proportional to its tendency to approach normal as a result of rest, sleep, sedation or anesthesia. There are rarely any symptoms associated with fluctuations of blood pressure in cases of essential hypertension and the patient's chance of predicting the level of his blood pressure accurately is usually no better than if he had guessed. This situation is sharply in contrast to paroxysmal hypertension associated with chromaffin tumors, in which the changes in blood pressure are more abrupt.

The effects on the blood pressure of the immersion in ice water of a hand of a patient with hypertension duplicates roughly the effects of such stimuli as strong emotions and tobacco smoking on the blood pressure. The increase in blood pressure produced by the cold stimulus is roughly in inverse proportion to the level of blood pressure when the test is performed for there is a "ceiling" beyond which the pressure will not go. This is usually about 250 mm. for the systolic pressure and 150 mm. for the diastolic pressure. The clinical significance of the sharp increases in blood pressure which result from the application of the cold pressor test is that hypertensive patients have excessive vasoconstriction as a result of hyperirritable sympathetic arteriolar systems.

Paroxysmal Hypertension Associated With Pheochromocytomas

Pheochromocytomas, of which about two-thirds are in the suprarenal glands, affect individuals from sixteen to sixty-nine years of age and cause paroxysms of hypertension as often as several times daily. The episodes of hypertension may last for one to two hours or for only two or three minutes. They occur spontaneously or are induced by physical exertion, sneezing, bending the body in various di-

rections or by pressure on the abdomen. The following symptoms occur during attacks: (1) palpitation (in almost all cases), (2) pain (in about five-sixths of the cases) which is precordial, epigastric, or is stimulated in the head, (3) vomiting (in about two-thirds of the cases), (4) rapid respiration (in about two-thirds of the cases), and (5) sweating (in three-fourths of the cases). During attacks the face of the patient becomes pallid or cyanosed. In some instances there is alternate flushing and blanching. Distention of the veins of the neck may occur. Convulsions, chills and fever are absent except that fever may occur shortly before death. The blood pressure is increased during attacks and there may be wave-like variations over a wide range. The pulse rate may increase or decrease, or it may not be changed. Hypertension may be present between attacks (in about half of the cases). The diagnosis is based on the occurrence of characteristic clinical episodes associated with paroxysms of hypertension, palpable abdominal tumor (in half of the cases) and positive roentgenologic findings (in about two-thirds of the cases). Hyperglycemia and glycosuria may occur during paroxysms.

The chief diagnostic difficulty is in differentiating episodes of elevation of blood pressure resulting from psychic stimuli and episodes originating from pheochromocytomas. In the former instance the emotional disturbance is more prominent, pain, tachycardia, sweating and discoloration of the face are minimal or absent; the elevation of the blood pressure is less marked and there is no physical evidence of tumor.

Orthostatic Hypotension

Ordinarily the blood pressure rises on assuming the erect position but in cases of orthostatic hypotension it decreases. The commonest symptom of this condition is weakness on assuming the erect position. Additional symptoms are deficient sweating, failure of pulse rate to increase normally on assumption of the erect posture, accentuation of symptoms in warm weather and excretion of larger amounts of urine when the patient is recumbent than when he is erect.

Miscellaneous

Holding one's breath or grunting may markedly increase the blood pressure. Pain, fear, excitement, anger and muscular effort almost routinely cause increase in blood pressure, and the blood pressure decreases during sleep. Sudden wide fluctuations in blood pressure may occur with episodes of angina pectoris, in cases of lymphosarcoma of the superior mediastinum, in cases of carcinoma of the larynx or esophagus and in cases of meningitis. Tobacco smoking may cause a marked increase in the blood pressure, especially in the presence of an inherently hyperreactive vascular system. The blood pressure is almost always higher in the leg than it is in the arm. When it is not, coarctation of the aorta should be suspected. Blood pressure is unequal in the two arms in about half of normal persons. The average inequality in the systolic blood pressure and in the diastolic blood pressure is about 13 mm. of mercury. These differences are not constant but transient, and it is reasonably certain that all people have inequality of blood pressure in the two arms at some time. Naturally, one should suspect organic disease when differences are marked and persistent.

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